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earth's surface, as well as of long intervals of time, marked by great foldings and disturbance, and by vast and wide-spread erosion of the successive series of rocks.

In conclusion, the writer took occasion to call attention to the important labors of the present school of Italian geologists, and their great zeal, skill and disinterested service, as shown in the memoirs of the R. Academia dei Lincei, and in the work of the Royal Geological Commission, including the special studies, maps and memoirs prepared by it for the International Geological Congress of Bologna in 1881. The new Geological Society of Italy, founded at the same date, gives promise of a brilliant future, and has already published many important memoirs.

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THE ACHENIAL HAIRS OF TOWNSENDIA.

BY PROFESSOR G. MACLOSKIE.

THE genus Townsendia of Hooker, belonging to the Asteroid Compositæ, includes about seventeen species, inhabitants of the Rocky Mountain region from New Mexico and Colorado to Eastern California. They are remarkable for the prostrate, hoary habit of most of the species, the linear or spathulate leaves being crowded in rosettes around the rather large flower-heads; the hemispherical or broad campanulate involucre consisting of a few series of imbricating lanceolate bracts with scarious lacerate margins; the plane receptacle; the anthers obtuse at the base; the flattened branches and lanceolate appendages of the styles of the disk-flowers; and most of all for the pappus of the disk-flowers consisting of many (fifteen to thirty) stout bristles, thickened downwards, unequal and scabrid or barbellate. One species (*T. eximia*) has the pappus consisting of two chaff-like bristles arising from a ring of coalescing scales; and in several species the pappus of the ray-flowers is shorter than in the disk, or consists in whole or in part of scales. *T. wilcoxiana* has the pappus very long and fine upwards, but its bristles are thickened or rigid below; and in *T. spathulata* the pappus-bristles are somewhat slender, but their bases are thickened and coalescing into a ring, so that all fall off together. The achenes are flattened with the two angles thickened; sometimes those of the ray-flowers are triquetrous; they are narrow-obovate and more or less pubescent, save in *T. eximia*, where they are broad-ovate and glabrous.

In Professor Asa Gray's synopsis of the species of this difficult genus,[1] the species are arranged in two sections, according to the size of the flower-heads and the more or less decided acumination of the involucral bracts; and for sub-sections most use is made of the characters of the achenial hairs. In some of the species the hairs covering the fruit are described as acute or 1–2 dentate, or again as 2–3 cleft or bracted; and in a large sub-section (including ten out of the seventeen species) the distinguishing character is "achenial hairs *glochidiate-capitellate*, *i. e.*, briefly bidentate at the apex, the teeth obtuse, recurved and sub-glandular (?)," whilst an additional species of a preceding section is shown to have similar hairs. This peculiarity of the hairs is referred to in Torrey and Gray's Flora of North America as to *T. sericea* ("hairs minutely capitate"), but not as to any of the other species. In Vol. VI of Wheeler's Survey it seems to be indicated in the plate of *T. Rothrockii.*

In a former paper[2] I described and figured the curiously hooked hairs of the fruit of *T. grandiflora*, and explained them as a special case of the duplex hairs which I had found to be characteristic of the Asteroideæ and of most of the other tribes of the Compositæ. Professor Gray kindly suggested that I ought to extend my examination to all the species of Townsendia, and for this purpose he generously furnished me with materials from the Harvard collections. I have also to acknowledge additional specimens kindly furnished by Professor Vasey, of the Agricultural Department at Washington.

My first step was to test the glabrous achenes of *T. eximia*, as previous experience had shown that the glabrous species of genera belonging to what I may term the duplex tribes, themselves bear some duplex hairs, few in number or reduced in size, but sufficient to establish their affinity. It was consequently no surprise to observe in the first shred examined from the achenial wall of *T. eximia*, several stout duplex hairs (each $.23^{mm}$ by 0.27^{mm}) with abruptly divaricating and slightly recurving tips, a decided case of the "glochidiate-capitellate" pattern. These hairs are so sparse as not to disturb the specific qualification of "glabrous achenes;" but they justify its reference to this genus, notwithstanding its chaffy pappus, and suggest that it (along with *T.*

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[1] Proc. Amer. Acad. Arts and Sci., Vol. XVI, p. 82 (1880).

[2] On the Achenial Hairs of Compositæ, AMERICAN NATURALIST, Jan. 1883.

grandiflora) may be well shifted into closer proximity with the glochidiate sub-section.

The next step was to examine the species represented as having simple hairs. I was prepared for such, because in other genera I have sometimes found the simple (as also the multicellular) hairs of the perianth invading the achenial surface so as to become intermingled with the duplex hairs. But in Townsendia no such phenomenon has as yet presented itself to my view. Although quasi-simple hairs abound on the achenes of some of the species, they are all really duplex. For descriptive purposes the term "simple" may perhaps be retained; but they are only apparently such. The semi-hairs sometimes grow finer upwards, ending in a straight point; the companion semi-hair will then be shorter, with its point hiding in the wall of the longer one, or with the point slightly or even abruptly diverging; and in these cases a third division may be sometimes seen nearer the base, thus giving variously the aspect of hair simple, or two-, or even three-toothed; in such cases the semi-tubes of the composite hairs are unequal; a third tooth sometimes arises from an extra process on a semi-hair. In *T. florifer*, where the point of one semi-hair was frequently hid behind the other, by rolling it under the cover glass we could readily bring it into view. Occasional triplicity of these hairs accords with what occurs in other genera, and is caused by one of the basal cells growing up beside the semi-hair which it bears; we have observed it in some species of Townsendia not so described in the Synopsis (*T. Parryi*, *T. wilcoxiana*, &c.), and it may perhaps be expected as an occasional variation, at least, in all the non-glochidiate species.

The "glochidiate-capitellate" character is merely incidental to the general binary structure of the hair. When the semi-hairs are of equal dimensions throughout, and when they rise to the same level before they abruptly diverge, then the diverging extremities spread out and recurve like the two flukes of an anchor; and in one species (*T. wilcoxiana*) the whole duplex hair is very long and slender, and its long extremities are circinately recurved. The average dimensions of the hairs in the other species is .28^{mm} to .35^{mm} long, by .022^{mm} in breadth. Each of them is a double tube, like the two barrels of a fowling-piece. In a broken hair of *T. Rothrockii* I was able to chase air-bubbles up and down the tubules, those in adjoining tubes being independent of each other, and to expel the bubbles at the fracture. On placing unbroken hairs in fluid, one may observe the fluid penetrating the wall and very quickly displacing the enclosed air.

The quasi-glandular appearance of the diverging and recurving extremities of these hairs in some of the species, may be a case of sphacelation, the delicate apex contracting as it withers, and its contents becoming discolored. It is not impossible, however, that the basal cell of the upper semi-hair (the one next the apex of the achene) is a glandular sac; as it appears to become gorged with fluid, and so to erect the hair which swings on the basal cell of the lower semi-tube as on a hinge.

Many of the hairs of *T. spathulata*, and sometimes those of other glochidiate species, have one of the semi-hairs ending sooner than its comrade, sometimes just at the place for diverging. In this way we get a uni-glochidiate condition (like an anchor with only one fluke).

The examination of *T. Watsoni* started a difficulty which I have not been able to solve. Gray describes its achenial hairs as "short, obtuse, or having 2–3 obtuse apical teeth;" I find them in the specimens under examination to be .3^{mm} to .34^{mm} long (with a few short ones intermingled), the semi-tubes not diverging, somewhat swollen at the extremity, occasionally one of the semi-tubes outgrowing its comrade and then slightly bending outwards. I do not find any of them lobed or toothed or triple (an extra tooth may grow on one of the semi-hairs). But it ought to be remembered that the entire condition may be in order of growth the forerunner of the divided condition; this I have seen to be the case in other genera. The same explanation may apply to *T. condensata*, whose achenial hairs in the specimen before me are obtuse, one of the semi-hairs slightly exceeding the other; perhaps they divide at a later stage.

With these reservations and explanations the following analysis is submitted as an attempt to bring together all the glochidiate-capitellate species, and to marshal the other species around them. *T. wilcoxiana* may get a sub-section for itself, being well characterized by its very long pappus (11^{mm}, the average of the other species being 6^{mm}), and its long and delicate duplex-hairs with their circinately rolled tips. *T. Watsoni* seems, by its achenial hairs, to come near *T. condensata*, but other characters prevent their approximation. *T. condensata* has a number of slender capillary filaments intermingled with the stout pappus-bristles. Three species *T. Fendleri*, *T. mexicana* and *T. Watsoni* have very short achenes. For the other characters used in drawing out the following analysis, I am indebted almost exclusively to Gray's synopsis of the genus.

SPECIES OF TOWNSENDIA, HOOK.

A. Involucral-bracts decidedly acuminate; head large.

a. Low, wooly, perennial, with soft linear involucral-bracts. Pappus of about thirty bristles, with capillary filaments interposed. Achenial hairs obtuse, sometimes slightly and unequally toothed. 1. *T. condensata*.

b. Caulescent annuals or biennials with deciduous pubescence, and broad lanceolate involucral-bracts.

* Pappus of disk plurisetose; achenes narrow-obovate.

Erect; leaves spathulate, achene pubescent with acute or 1–2-toothed hairs. 2. *T. Parryi*.

Spreading; leaves narrow, ray-pappus of short scales; achenial hairs glochidiate. 3. *T. grandiflora*.

** Pappus of 2 subulate, chaff-like bristles rising from a crown of short scales; achenes broad-obovate, glabrous, but with a few stout glochidiate hairs. 4. *T. eximia*.

B. Involucral-bracts slightly or not acuminate; heads smaller or narrower.

c. Achenial hairs glochidiate, their tips usually recurving.

* Head about $\frac{3}{4}$ inch broad, sessile. Leaves broad-spathulate, glabrous. 5. *T. Rothrockii*.

** Heads about $\frac{2}{3}$–$\frac{1}{3}$ inch broad, usually sessile. Plants silky or strigulose pubescent.

Depressed acaulescent; leaves linear or linear-spathulate, crowded around the head; involucral bracts mostly acute. 6. *T. sericea*.

Depressed sub-caulescent; leaves spathulate, short ($\frac{1}{2}$ inch long) around the hemispherical head; involucral-bracts mostly obtuse. 7. *T. arizonica*.

Depressed caulescent or sub-caulescent; leaves narrow-spathulate and linear, the upper ones supporting the head; involucral-bracts silky; somewhat obtuse; pappus of ray much shorter than of disk. 8. *T. incana*.

*** Heads about $\frac{1}{3}$ inch broad, sessile; leaves spathulate, villous-wooly; pappus-bristles coalescing at base into a ring, and falling off together. 9. *T. spathulata*.

**** Heads $\frac{1}{4}$ inch broad, hemispherical, usually short-pedunculate; involucral-bracts broad-lanceolate, slightly acute.

† Leaves and involucre glabrous, the leaves thickish, spathulate, the upper ones slightly exceeding the peduncle. 10. *T. glabella*.

†† Fine hoary pubescence; ray-pappus a crown of short scales, 1–2 setæ being often added.

‡ Leaves linear; involucral-bracts 3-seriate, unequal, acute; achenes short ($2\frac{1}{2}^{mm}$). 11. *T. Fendleri*.

‡‡ Leaves spathulate below, upper ones linear.

Involucral-bracts 2-seriate, rather broad, somewhat acute, outer ones shorter. 12. *T. strigosa*.

Involucral-bracts 2-seriate, equal, obtuse; achene small ($2\frac{1}{4}^{\mathrm{mm}}$).
13. *T. mexicana.*

d. Achenial hairs long, slender; their branches long and circinately rolled downwards; heads ¾ inch broad; pappus of very long bristles (11^{mm}), thickening at base; plant depressed, acaulescent, glabrous.
14. *T. wilcoxiana.*

e. Achenial hairs obtuse, entire when young, afterwards 2-lobed; plant branching from root; head short-pedunculate, mid-sized; achenes short ($2\frac{1}{2}^{\mathrm{mm}}$); leaves narrow-spathulate. 15. *T. Watsoni.*

f. Achenial hairs simple or bifid, the lobes acute; heads mid-sized, peduncle mostly naked.

Leaves cauline, linear, or the lowest sub-subspathulate, acute or acuminate; involucral-bracts linear-lanceolate. 16. *T. florifer.*

Leaves radical, spathulate, their limb mostly broad and short; heads on short scapes; involucral bracts somewhat broad-lanceolate.
17. *T. scapigera.*

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THE HIBERNACULA OF HERBS.

BY AUG. F. FOERSTE.

IN the fall of the year, as the weather grows colder, the production of the normal leaves of trees is suddenly checked. They wither and fall off. Instead of them we find a close, compact cluster of scales, and within these a number of young leaves and sometimes flower-buds. These scales are designed to protect the young leaves and flowers from the cold during winter; they are therefore called the *hibernacula* or winter quarters of the tender parts. Towards spring the growth of the inclosed leaves and buds is very rapid, so as to burst open their coverings and allow a speedy development of the floral organs. Hence most trees possessing scaly buds flower early in the spring of the year.

It may not be as well known, however, that it is not at all uncommon for the earlier flowering, perennial herbs to possess hibernacula, or winter buds, containing the flowers of the following year; and that many of them owe the power of early developing their flowers to this fact. On the study of a great variety of herbs belonging to all classes of flowering plants, during the winter months, it became evident that such cases were by no means rare. Such a study may reveal also many other interesting facts as the following pages will show.

Perennial herbs, on the approach of winter, die down to the surface of the ground. The stem still remaining beneath the earth is called the subterranean stem, and furnishes the buds from